ELECTRONIC NAVIGATION INDUSTRIES, INC.

OPERATING AND SERVICE INSTRUCTIONS
MODEL 310L
BROADBAND RF POWER AMPLIFIER

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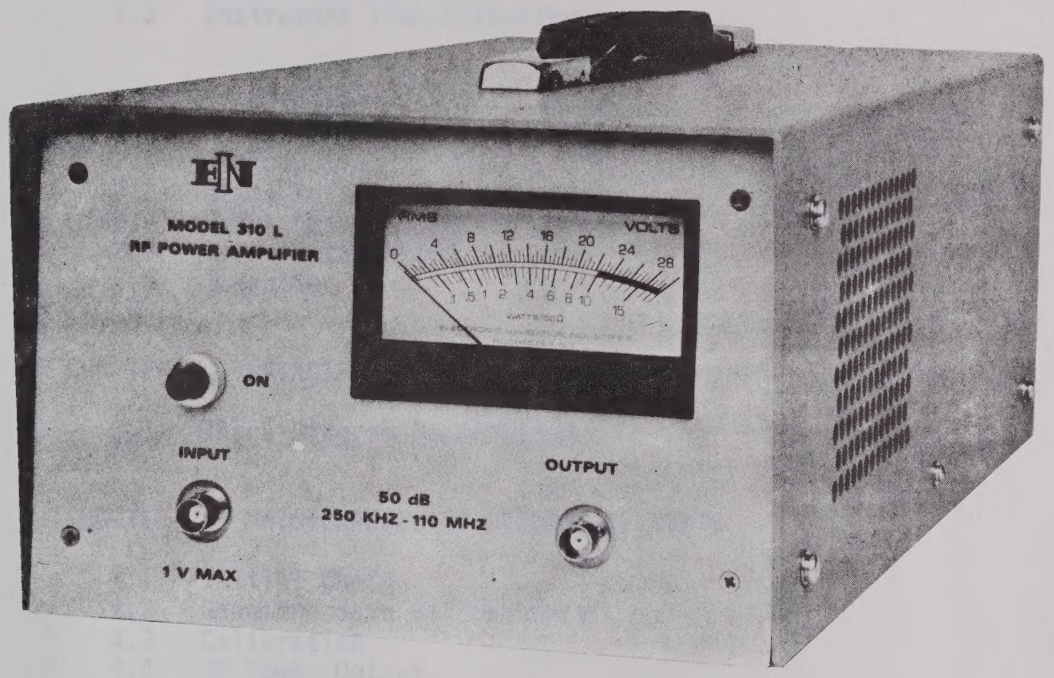

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CHAPTER 1
GENERAL INFOMATION

1.1 INTRODUCTION

The Model 310L is a broadband solid state power amplifier covering the frequency range of 250 KHz to 110 MHz.

Over 10 watts of RF power can be produced at the output, with low harmonic and intermodulation distortion. A highly linear Class A design, the Model 310L will amplify inputs of AM,FM, SSB, pulse and other complex modulations, with minimum distortion. The 50 dB gain of the unit permits it to be driven to its full power output by any signal or sweep generator capable of supplying a minimum -10 dBM (.07 volts RMS) signal level into its 50 ohm input. Virtually all commercial signal and sweep generators are capable of supplying this signal.

The Model 310L operates over its entire bandwidth without tuning or other adjustments. It is capable of supplying useful power output up 150 MHz, at reduced gain.

This unit is unconditionally stable and will not oscillate for any possible combination of source and load impedances. It is protected against failure due to output load mismatch and/or overdrive. The Model 310L will withstand a +25 dB overdrive (input signal of +15 dBM) for all output load conditions including both short and open circuit loads.

Output RF voltage level, as well as power output into 50 ohms, is monitored by a front panel meter. An integral power supply permits operation directly from the AC line.

1.2 SPECIFICATIONS

Physical and electrical specifications are listed in Table 1-1.

1.3 INSTRUMENT IDENTIFICATION

Each amplifier is identified by a serial number tag on the rear panel of the unit. Both the model number and the serial number should be given in any correspondence with the company.

TABLE 1-1. SPECIFICATION

FREQUENCY COVERAGE:	250 KHz to 110 MHz without tuning.
MAXIMUM POWER OUTPUT:	10 watts CW and PEP (Peak Envelope Power) at rated distortion; higher power output at increased distortion.
INPUT SIGNALS:	Unit will accept CW, AM,FM, SSB, Wideband Sweep and other complex modulations, limited only by their bandwidth and peak input level.
GAIN:	50 dB nominal
GAIN VARIATION:	Less than ±1 dB over the entire frequency range at power outputs below 2 watts. Less than ±1.5 dB for power outputs between 2 and 10 watts.
TOTAL HARMONIC DISTORTION:	All harmonics more than 25dB down at full power output, lower at reduced power output.
3RD ORDER INTERMODULATION DISTORTION:	More than 30 dB down (typical) from 0.25 - 40 MHz from 40 - 110 MHz at full power output.
TYPICAL 3RD ORDER INTERMODULATION INTERCEPT POINT:	+49 dBM
INPUT-OUTPUT IMPEDANCE:	50 ohms
INPUT VSWR:	Less than 1.3
OUTPUT VSWR:	Less than 2.0 (typical)
NOISE FIGURE:	Less than 12 dB
STABILITY:	Unconditionally stable; unit will not oscillate for any condition of load and source impedances.
PROTECTION:	Unit will withstand a +25 dB overdrive (input signal of +15dBM) for all output load conditions, including short and open circuit loads.
OUTPUT METERING:	Average reading voltmeter, calibrated in RMS volts for a sine wave, with an accuracy of ±3% of full scale (0-30 volts); also calibrated in watts into 50 ohms (0-18 watts)

POWER REQUIREMENTS:	115-230 VAC ± 10% 50-60 HZ, 150 watts
OPERATING TEMPERATURE:	0° to +50° C.
SIZE:	6 x 8½ x 15 inches 15.2 x 21.6 x 38.1 CM
WEIGHT:	20 lbs 9.1 Kg
INPUT AND OUTPUT CONNECTORS:	BNC

CHAPTER 2
OPERATION

2.1 INTRODUCTION

The ENI Model 310L Amplifier will increase the RF output level of signal sources in the 250 KHz to 110 MHz range.

The input and output are connected via the front panel BNC connectors to the signal source and load respectively.

2.2 MAINS VOLTAGE SETTING

The supply voltage selection switch is located at the rear of the unit and is normally set for 115VAC operation. Before connecting the unit to the mains supply, check that the supply voltage switch is correctly set.

EXTENSIVE DAMAGE WILL RESULT IF THE AMPLIFIER IS CONNECTED TO THE WRONG SUPPLY VOLTAGE. UNDER NO CIRCUMSTANCES SHOULD THIS SWITCH BE OPERATED WHILE THE SUPPLY IS CONNECTED.

2.3 MAINS FUSE RATING

The mains fuse F1 is located on the rear panel. The replacement part number is 313004 4ASB.

2.4 RACK INSTALLATION

For standard nineteen inch rack installations, an optional rack mounting kit 310LR is available.

2.5 OPERATION

Connect the signal source to the BNC and the load to the output BNC with 50 ohm coaxial leads.

When the Model 310L is connected to a 50 ohm load, the CW power output of the unit may be read directly from the meter scale.

The input signal should be increased gradually while observing the output voltage on the output RF voltmeter. Input signal voltage should never be allowed to exceed 1 volt RMS (1.4volts peak).

The red portion of the meter indicates that the amplifier is no longer operating in its most linear region and increased distortion may result. This occurs at 10 watts (PEP of CW) of RF output power into 50 ohms (31.4 volts peak).

When the amplifier is connected to an arbitrary or unknown load impedance, the following procedure will insure low distortion power output.

(1) Disconnect the output load cable from the output BNC connector of the Model 310L.

(2) If the CW output voltage is less than the red line value (22.5 volts RMS), the unit is operating at low distortion regardless of the load impedance.

(3) Reconnect the output of the amplifier to the load.

If the output of the amplifier is monitored by a high frequency oscilloscope (or spectrum analyzer), the input signal may be increased until the point of maximum undistorted power output is observed.

CHAPTER 3

PRINCIPLES OF OPERATION

3.1 BLOCK DIAGRAM DESCRIPTION

A block diagram of the entire 310L is shown in Figure 3.1

Input signal from the front panel BNC is fed to the preamplifier module. The preamplifier 310L-4142 has four equal amplitude and phase outputs. These are fed via RG 174 coaxial cable to the inputs of the four power amplifier modules, 310L-4141. Each preamplifier channel has an overall gain of 24 dB and a maximum power output of 100 milliwatts into 50 ohms. A factory adjusted peaking control C5 compensates for the high frequency gain roll-off of the power amplifier modules.

The Model 310L achieves its power output by combining the outputs of eight separate power amplifier stages. Hybrid combiners couple the individual stage outputs to the main amplifier output. The stages are highly isolated by these combiners and between stage interaction is negligible. Four power amplifier modules, 310L-4141, consisting of two output stages each, are mounted symmetrically on the 310 heat sink.

Each of the four power amplifier modules has a 50 ohm input and output impedance. The inputs are mounted at the bottom of the modules and the outputs are located at their tops. The modules are individually adjusted for a maximum power of 3 watts output and have a gain of approximately 20dB at the low end of the frequency range, decreasing to 16 dB at 110 MHz.

The outputs of the power amplifiers are combined in the final combining module 310L-4144. This hybrid combiner covers the entire frequency range with a maximum of 0.5dB insertion loss. The main output of the combining module is fed via coaxial cable to the front panel output BNC connector.

The RF voltmeter module 310L-4145 is connected to the output BNC connector. It samples the RF voltage present at that point and produces a DC voltage proportional to its average value. This DCoutput is fed to the front panel meter, which is calibrated in RMS volts for a sine wave and also in watts into 50 ohms.

The entire unit is powered by a regulated power supply capable of supplying +25.5 volts DC at a current of four amperes. The power supply circuit module 310L-3142 is mounted directly below the RF assembly in the path of the forced air cooling. DC voltage adjustment is accomplished by a variable control mounted on the module. A short circuit protection control located next to the output control is set at the factory to protect against damage due to inadvertent (short time) output short circuits. The DC output current is fed in series with a thermostat mounted on the rear of the power supply. Should the fan fail or dirt in the filter screen prevent adequate cooling, the thermostat will open and prevent damage to the unit.

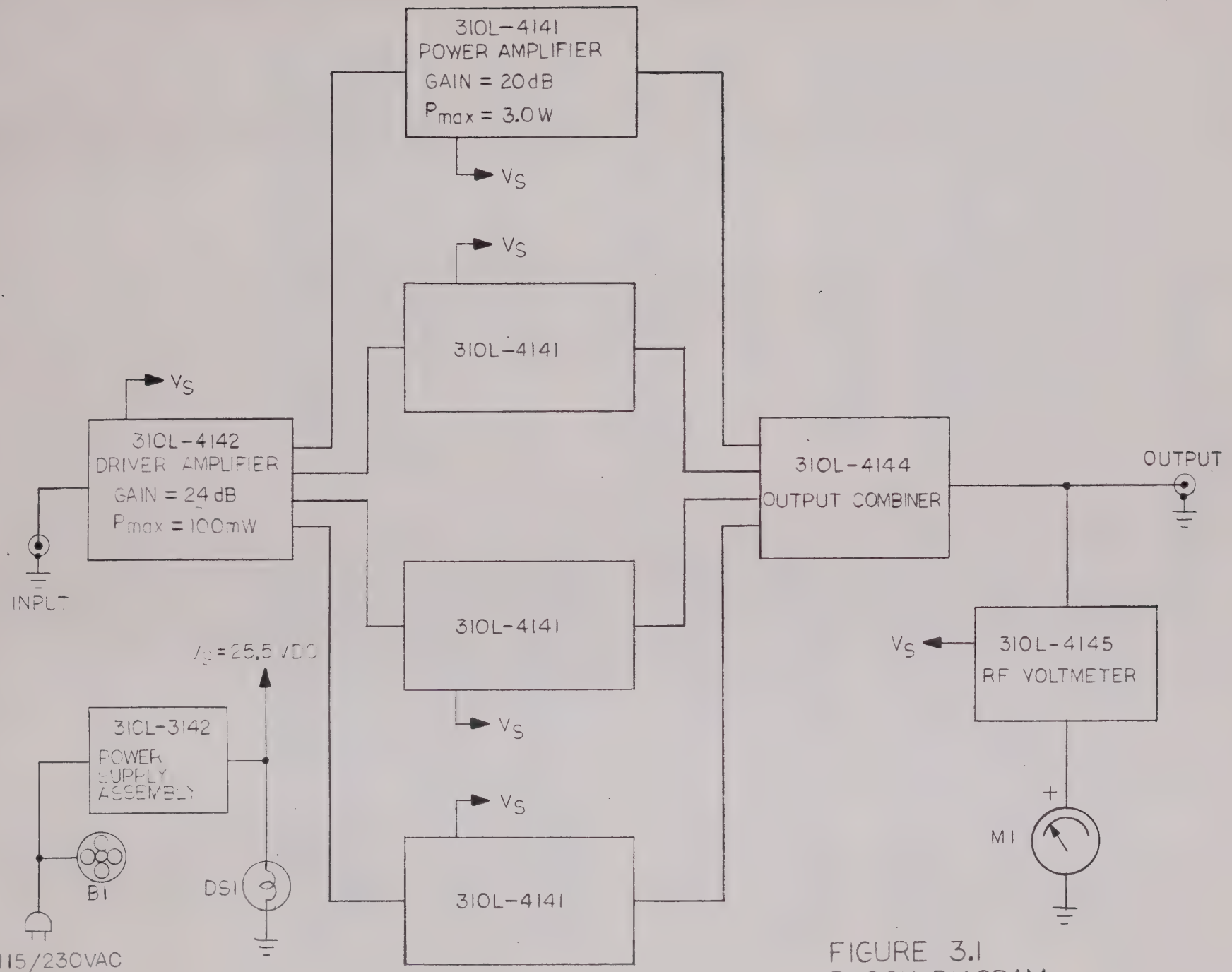


FIGURE 3.1
BLOCK DIAGRAM

CHAPTER 4

MAINTENANCE AND PERFORMANCE TESTS

4.1 INITIAL CHECK

Before connecting the Model 310L to the mains supply, make certain that the supply voltage switch on the rear panel is in the proper position.

EXTENSIVE DAMAGE WILL RESULT IF THE AMPLIFIER IS CONNECTED TO THE WRONG SUPPLY VOLTAGE. UNDER NO CIRCUMSTANCES SHOULD THIS SWITCH BE OPERATED WHILE THE SUPPLY IS CONNECTED.

Connect the unit to the mains supply, switch it on and observe that the indicator lamp illuminates.

4.2 GAIN AND GAIN VS FREQUENCY

Equipment Required:

a) Oscilloscope (Tektronix T921)
b) Sweep signal generator (HP 8601A)
c) 50 ohm video detector (Wavetek D151)
d) 10dB 75w attenuator (EMCO)

Procedure:

a) Set the oscilloscope to DC, triggering source to external (X-Y), and volts/division to 20mV/CM.

b) Set the sweep/generator to video sweep and the frequency to 110 MHz. Connect the RF output of the generator to the input of the attenuator. Connect the video detector to the output of the attenuator and to the vertical input of the oscilloscope. Connect the sweep output of the generator to the horizontal input of the oscilloscope.

c) Adjust the output level of the sweep generator for full vertical deflection on the oscilloscope face.

d) Calibrate the scope face to show 2dB in 1dB steps and mark the traces with a grease pencil.

e) Rotate the step attenuator on the sweep generator until the output is reduced a total of 50dB from the original full vertical deflection reference point.

f) Connect the RF output of the sweep generator to the input of the 310L and the attenuator to the output.

g) Switch the unit on and observe the oscilloscope. The gain should typically be 50dB and the sweep trace should be within the 2dB markings.

4.3 CALIBRATION

Generally there are no adjustments necessary on the 310L. However, there is one adjustment to level the gain versus frequency response if needed:

Remove the cover by removing the screws on both sides of the unit. Set up the gain versus frequency test as outlined in section 4.2.

If the gain vs frequency response shows a variation of greater than ±1dB, locate the driver board (310L-4142) and adjust the variable capacitor C5 with a plastic alignment tool until maximum gain flatness occurs.

4.4 RF POWER OUTPUT

The purpose of this test is to verify that the model 310L will deliver its rated power over the frequency range of 0.25 MHz to 110 MHz.

Equipment Required:

a) Signal generator (HP8601A)
b) Calorimetric power meter (HP434A)
c) Attenuator 10dB 75W (EMCO)

Procedure:

a) Connect the output of the signal generator to the input of the 310L. Connect the attenuator to the output of the 310L and to the input of the calorimetric power meter.

b) Set the signal generator to CW and the frequency to 110 MHz. Select the appropriate range on the power meter.

c) Switch the unit on and Increase the gain of the generator until the power meter reads 10.0 watts. Do not overdrive the amplifier. The 310L will withstand +15dBM of drive, however, it will saturate before that point.

d) Scan the range of the amplifier (0.25 MHz-110 MHz) and verify that the output is 10.0 watts or greater.

4.5 MEASUREMENT OF HARMONICS

Equipment Required:

a) Signal generator (HP 8601A)
b) Calorimeter power meter (HP 434A)
c) Spectrum analyzer
d) Attenuator 10dB 75W (EMCO)
e) Attenuator 30dB

Procedure:

a) Set the signal generator to 45 MHz CW. Connect the RF output to the input of the 310L. Connect the output of the 310L to the 10dB 75W attenuator and then to the input of the calorimetric power meter. Switch the unit on and adjust the gain for an output of 10 watts. Disconnect the output of the 10dB attenuator and connect the 30dB attenuator between it and the RF input of the spectrum analyzer. The level of the harmonics should be less than 25dB with respect to the carrier. Repeat the above procedure at other frequencies from 0.25 MHz to 110 MHz.

4.6 TROUBLESHOOTING AND REPAIR

If the Model 310L should fail to operate, and the panel light does not glow, check the condition of the fuse at the rear of the unit (4 ASB 313004).

If the unit cycles on and off over a period of time, check the conditions of the fan filter (see maintenance instructions, section 4.7).

Should the Model 310L fails to operate properly, each individual amplifier module may be tested for power output and frequency response in accordance with Figure 3 and following the test procedures of Section 4.1 to 4.5.

The Model 310L circuit modules should be serviced only by the factory or its authorized facility. However, ENI will supply pre-aligned and calibrated module boards as replacement items.

DO NOT ATTEMPT to probe the circuit modules while they are mounted in the amplifier case, as extensive damage may result.

When factory service is required, the following steps should be taken:

1) Notify us, giving full details of the difficulty. Include the instrument's serial number.

2) Upon receipt of shipping instructions, forward the instrument transportation prepaid, to the factory or to the authorized repair station indicated on the instructions.

If requested, an estimate of the charge will be made before the work begins, provided the instrument is not covered by the warranty.

4.7 MAINTENANCE

There are not periodic electric adjustments required to maintain the amplifier gain and power output characteristics.

Periodic cleaning and lubrication of the fan filter should be done every six months under ordinary service conditions. To remove the fan filter, insert a screw drive in the two top slots and gently pry it off. To clean the filter, it should be soaked in an industrial cleaner solution such as "Tolune" for two minutes. After drying thoroughly, lubricate it with a few drops of number 10 oil. To re-insert the filter, push in both sides, until the unit "clicks" into its holder.

4.8 PRECAUTIONS

(1) The Model 310L output is at DC ground potential through the final combining transformer. Therefore, the output should not be directly connected to a load on which there is a DC potential. If the output load has a DC potential, insert a series capacitor with the appropriate voltage breakdown rating (.1 mfd is the recommended value) between the load and the output cable.

(2) The input and output of the Model 310L should not be connected together. This will cause oscillation and may damage the input preamplifier.

(3) The 310L should not remain connected to an antenna when the unit is not in use. If thunderstorms are likely, it would be prudent to earth ground the unit's case.

When the input signal voltage of a drive source is unknown, insert an attenuator between it and the Model 310L input.

5.3 REPLACEMENT PARTS LIST

REFERENCE DESIGNATION	DESCRIPTION	MANUFACTURER'S CODE	PART NUMBER
	BASEPLATE ASSEMBLY	10226	310L-3141
T1	Transformer, Power	12715	AM5176A
	POWER SUPPLY ASSEMBLY	10226	310L-3142
CR1	Bridge Rectifier	04713	MDA-801
R5,R6	1 ohm Res., 5W	44655	4530
S3	Thermal switch	14604	2450-088-105
R2	2.7K ohm Res., 2% ½W	16299	HC5-2.7K
R1	7.5 ohm Res., 2% ½W	16299	HC5-7.5K
R3,R4	200 ohm POT	32997	3386T-1-201
C1	CAP. 3900 uF 50V	56289	36D392G050AC2A
C2	CAP. 560pFd	09023	CM06FD561J03
C3	CAP. 20 uFd 50V	56289	500D206G050DD7
IC1	IC Regulator	49956	RC723CT
Q1,Q2	Transistor	04713	2N3055
Q3	Transistor	79089	40312
	FRONT PANEL ANGLE ASSEMBLY	10226	310L-3145
J1,J2	BNC Connector	13511	UG625/U
	FRONT PANEL ASSEMBLY	10226	310L-3144
S1	Switch	87034	616-6-1
M1	Meter	10226	830-180B
DS1	Bulb	71744	327
	REAR PANEL ASSEMBLY	10226	310L-3143
B1	Fan	28875	WS210FL
F1	Fuse 4ASB	75915	313004
	DRIVER AMPLIFIER BOARD	10226	310L-4142
A5R1,R7	Res., 15 ohm ¼W 5%	10226	Carbon film
A5R12,R19,R21	Res., 18 ohm ¼W 5%	10226	Carbon film
A5R2,R3,R14,R23	Res., 51 ohm ¼4 5%	10226	Carbon film
A5R17,R24,R25	Res., 100 ohm ¼W 5%	10226	Carbon film

REFERENCE DESIGNATION	DESCRIPTION	MANUFACTURER'S CODE	PART NUMBER
A5R8,R11	Res. variable	10226	Carbon film
A5R16	Res. variable	10226	Carbon film
A5R13	Res. variable	10226	Carbon film
A5R4,R26	Res. 200 ohm ¼W 5%	10226	Carbon film
A5R6,A27	Res. 300 ohm ¼W 5%	10226	Carbon film
A5R18,R20	Res. 470 ohm ¼W 5%	10226	Carbon film
A5R5,R10	Res. 560 ohm ¼W 5%	10226	Carbon film
A5R9	Res. 1K ohm ¼W 5%	10226	Carbon film
A5R22	Res. 51 ohm 2W 5%	10226	Carbon film
A5R15	Res. 120 ohm 2W 5%	10226	Carbon film
A5C5	CAP 4-40 pF	02799	422
A5C2,C3,C8,C9	CAP .033 mfd 50V	36346	C320C333M5U ICA-C9250
A5C1,C4,C6,C7,C10 C13,C14	CAP .1 mfd 50V	36346	C330C104M5U ICA-C9250
A5C11,C12	CAP 22 pfd	09023	CM05ED220J03
A5L1	Choke .82 uHy	99800	1537-10
A5L2	Choke 1.0 uHy	99800	1537-12
A5L3,L4,L7	Choke 150 uHy	99800	3500-12
A5Q1,Q2,Q3,Q4	Transistor	10226	ENI 5744
A5T1,T2,T3,T4,T5, T6,T7,T8	Transformer	10226	
	POWER AMPLIFIER BOARD		300L-4141
A1R1	Res., 27 ohm ¼W 5%	10226	Carbon film
A1R6,R10	Res., 15 ohm ¼W 5%	10226	Carbon film
A1R3,R8,R16,R20	Res., 300 ohm ¼W 5%	10226	Carbon film
A1R4,R9	Res., 330 ohm ¼W 5%	10226	Carbon film
A1R2	Res., 27 ohm ½W 5%	10226	Carbon film
A1R14,R19	Res., 1K ohm ½W 5%	10226	Carbon film
A1R15,R21	Res., 240 ohm 1W 5%	10226	Metal film
A1R7,R11	Res., 560 ohm 1W 5%	10226	Metal film
A1R17,R22	Res., 12 ohm 2W 5%	10226	Metal film
A1R13,R18	Res., 39 ohm 2W 5%	10226	Metal film
A1R5,R12,R23,R24	Variable resistor		
A1C4,C5,C11,C12, C16,C17	Capacitor .033 uf 50V	36346	C320C333M5U ICA-C9250
A1C2,C3,C8,C9 C10,C13,C14,C15	Capacitor .1uf	36346	C330C474M5U ICA-C9250
A1C1	Capacitor 22 pF	09023	CM05ED220J03
A1C18,C19,C20	Capacitor 47 pF	09023	CM05ED470J03
A1C6,C7	Capacitor 56 pF	09023	CM05ED560J03

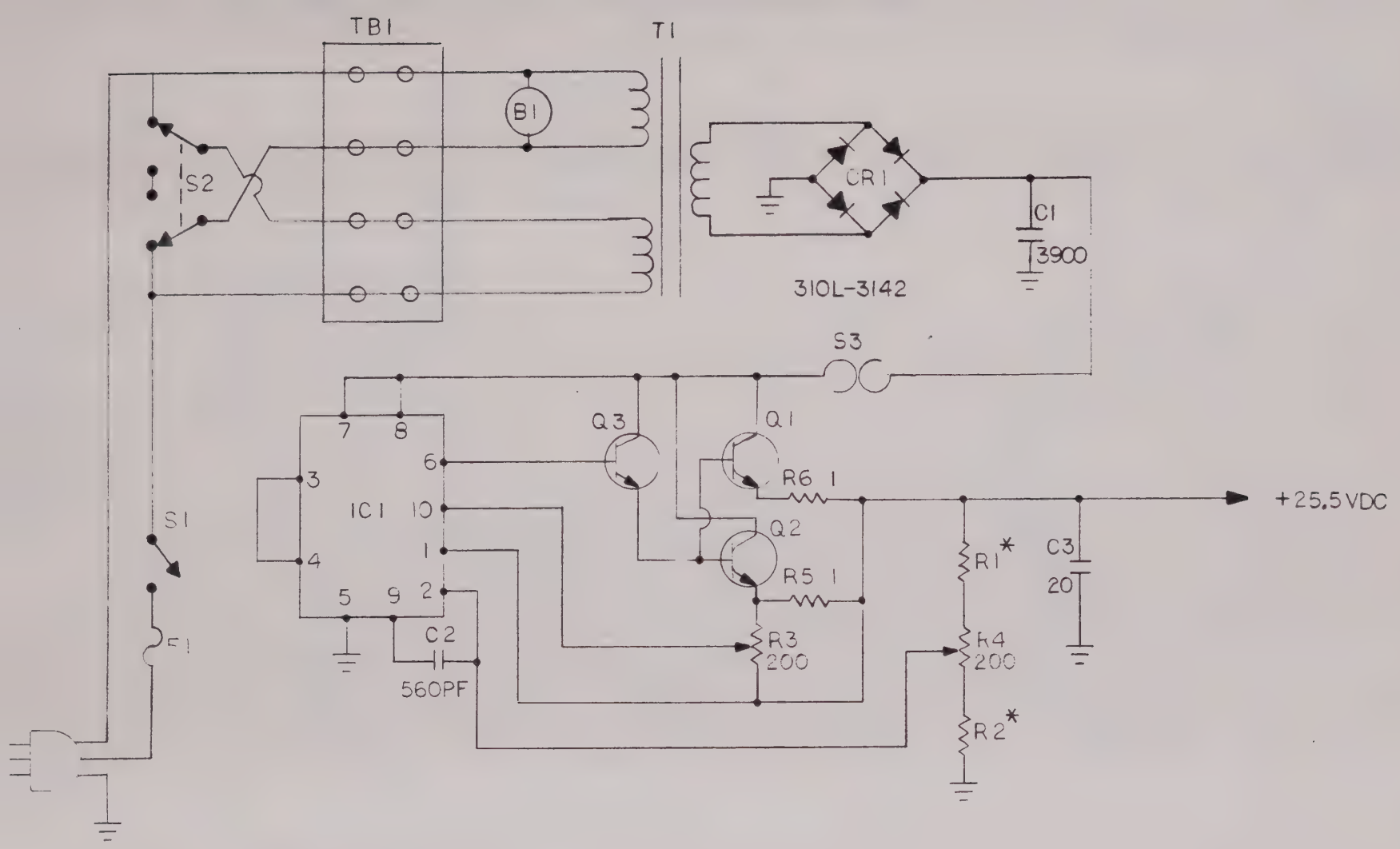
REFERENCE DESIGNATION	DESCRIPTION	MANUFACTURE'S CODE	PART NUMBER
A1L1,L2	Choke .68 uHy	09023	CM05ED560J03
A1L5,L6	Choke .82 uHy	99800	1537-08
A1L7,L8	Choke 100 uHy	99800	2890-42
A1L3,L4	Choke 150 uHy	99800	3500-12
A1Q3,Q4	Transistor	10226	PT 3642A
A1Q1,Q2	Transistor	10226	ENI 5744
A1T1,T2,T3,T4,T5,T6	Transformer	10226	
	COMBINER BOARD	10226	310L-4144
A11R1,R4	Res., 100 ohm 2W 5%	10226	
A11R2,R3	Res., 24 ohm 2W 5%	10226	
A11C1,C2	CAP 24 pFd	09023	CM05ED240J03
A11C3	CAP 30 pFd	09023	CM05ED300J03
A11T1,T2,T3,T4	Transformer	10226	
	RF VOLTMETER BOARD	10226	310L-4145
A12R1	Res., 22 ohm ¼W 5%	10226	Carbon film
A12R6	Res., 560 ohm ¼W 5%	10226	Carbon film
A12R5,R7	Res., 1.5 ohm ¼W 5%	10226	Carbon film
A12R3	Res., 2.2K ohm ¼W 5%	10226	Carbon film
A12R4	Res., 3K ohm ¼W 5%	10226	Carbon film
A12R2	POT. 1K ohm	32997	3386T-1-102
A12C1	CAP .033 uFd 50V	36346	C320C333M5U ICA-C9250
A12D1	Diode	28480	5082-2800

5.4 GLOSSARY OF ABBREVIATIONS

A.	AMPERES	PIV	PEAK INVERSE VOLTAGE
AMP	AMPERES	POT	POTENTIOMETER
ASSY	ASSEMBLY	REF	REFERENCE
BR	BRIDGE	REQ	REQUIRED
CAP	CAPACITOR	RES	RESISTOR
CER	CERAMIC	S.B.	SLOW BLOW
COMP	COMPOSITION CARBON	uF	MICROFARAD
		V	VOLTS
DESIG	DESIGNATION	VDCW	DC WORKING VOLTS
ELECT	ELECTROLYTIC	W	WATTS
I.C.	INTEGRATED CIRCUIT	WW	WIRE WOUND
K	KILOHMS		
uH	MICROHENRY		
mV	MILLIVOLTS		
pF	PICOFARAD		

5.5 LIST OF MANUFACTURERS

FEDERAL SUPPLY CODE	MANUFACTURER	ADDRESS
02799	Arco Pacific	Torrance, CA
04713	Motorola, Inc.	Phoenix, AZ
09023	Cornell-Dubilier Elec.	Sanford, NC
10226	Electronic Nagiation Ind.	Rochester, NY
12715	American Magnetics Corp.	Carterville, IL
13511	Amphenol Corp.	Los Gatos, CA
14604	Elmwood Sensors, Inc.	Cranston, RI
16299	Corning Glass	Raleigh, NC
28480	Hewlett Packard	Palo Alto, CA
28875	IMC Magnetics	Rochester, NH.
32997	Bournes, Inc.	Riverside, CA
36346	Union Carbide (Kemet)	New York, NY
44655	Ohmite Manufacturing Co.	Skokie, IL
49956	Raytheon Co.	Lexington, MA
56289	Sprague Electric Co.	North Adams, MA
71744	Chicago Miniature Lamp Works	Chicago, IL
75915	Littlefuse, Inc.	Des Plaines, IL
79089	RCA	Harrison, NY
87034	Marco Oak Ind.	Anaheim, CA
99800	Delevan Electronics Corp.	East Aurora, NY



NOTES:
UNLESS OTHERWISE SPECIFIED:

1) ALL RESISTOR VALUES ARE IN OHMS.
2) ALL CAPACITOR VALUES ARE IN MICROFARADS.
3 VARIABLE VALUE INDICATED BY *.

FIGURE 5.1
POWER DISTRIBUTION

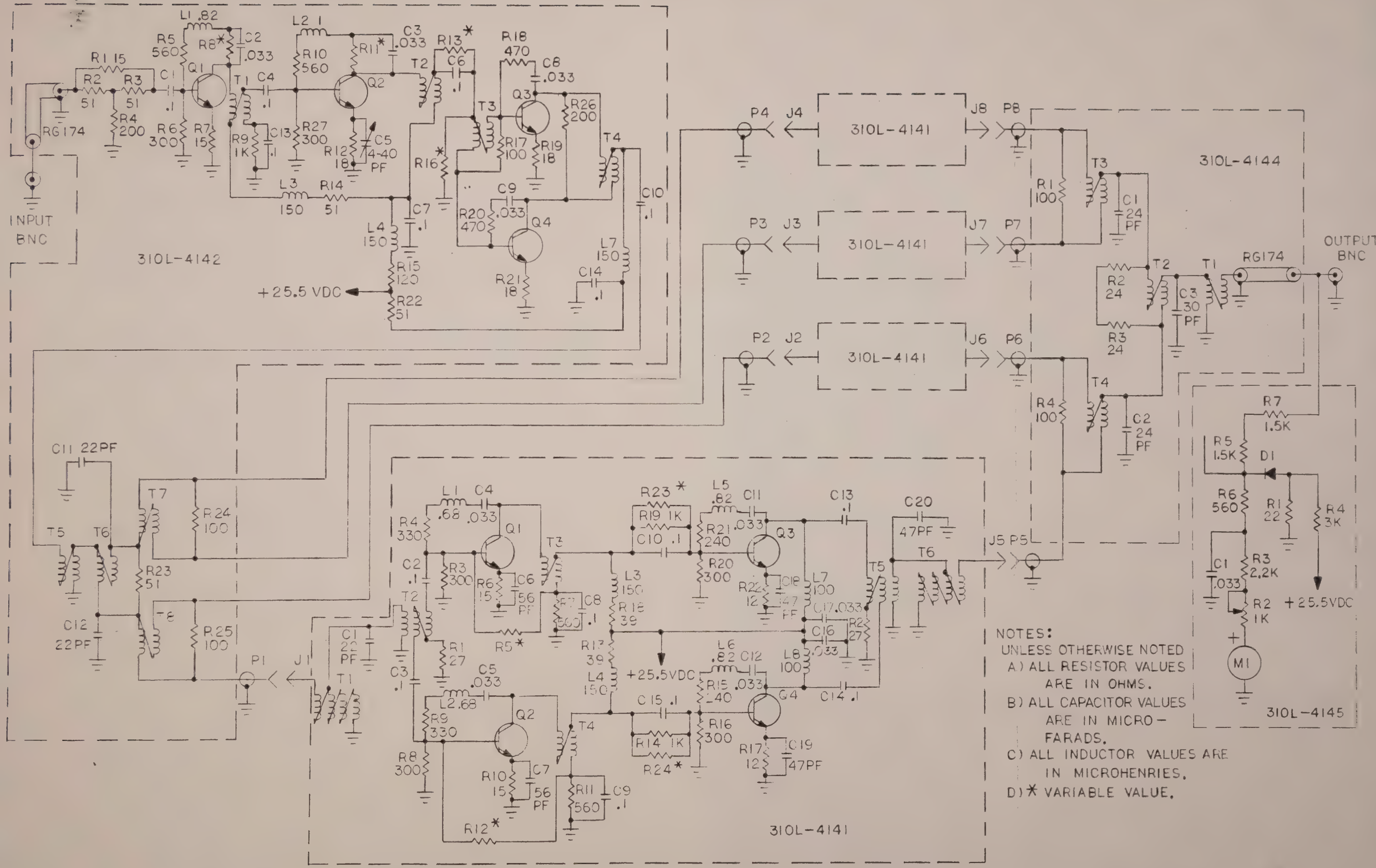


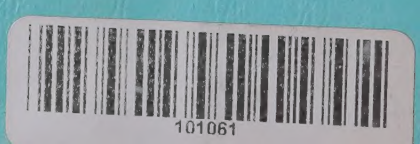
FIGURE 5.2
RF AMPLIFIER

WARRANTY

Electronic Navigation Industries, Inc. warrants each instrument to be free from defects in material and workmanship. Our liability under this warranty is limited to servicing and replacing any defective parts for a period of one (1) year after delivery to the original purchaser.

When warranty service is required, the instrument must be returned transportation charges prepaid to the factory or our authorized service facility. If in our opinion, the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at cost. In this case, an estimate will be submitted before the work is started.

There are no other warranties expressed or implied, including any warranty of merchantability or fitness. Seller shall not be responsible for any incidental or consequential damages arising from any breach of warranty.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